MI-8 Collimation Review

A review of design concepts, preliminary design and supporting calculations

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MI8 Collimation

Charge for MI-8 Collimation Review

The MI-8 collimation review committee is charged with answering the following questions about the proposed collimation system:

- Will the system be effective at intercepting beam halo at the level of 1% of the total beam current?
- Is the placement of the system optimal?
- At maximum absorption rates, is the integrated shielding sufficient in terms of:
  - External dose rates?
  - Sump and groundwater activation?
  - Residual dose?
  - Air activation?
- What are the requirements of the system in terms of beam position control and can these requirements reasonably be met?
- Is the mechanical and control design sound?
- Are the budget and schedule realistic?

It's understood that because the design is not complete, there will be a limit to how well the last two questions can be answered.

Eric Prebys
Proton Plan Manager

MI8 Collimation

Overview of MI8 Collimation Plan

Collimate tails of Booster Beam to reduce activation of MI Tunnel
- **Expect to greatly reduce number of hot locations**
- **Other losses will dominate total MI losses – need to localize them**

Use Booster Collimators for Mechanical Concepts
- **Different beam/civil construction constraints – more/simpler in MI8**
- **Lower weight so may be able to avoid slip plate for horizontal**
- **Allow more prompt radiation so able to use marble to reduce residual dose**

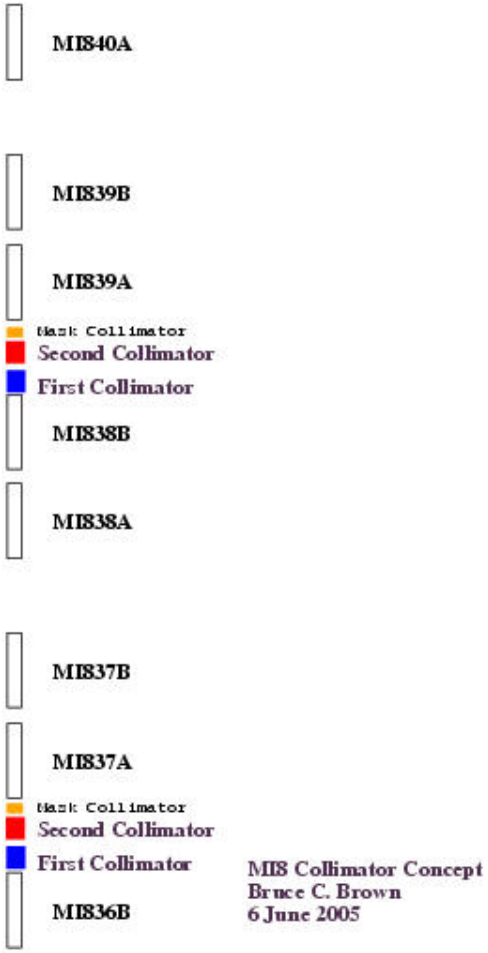
Beam position variation will cause higher losses than for symmetric case so must design for higher losses than just desired scraping.

Issues for commissioning and monitoring of loss not finalized. Protection against overheating required.

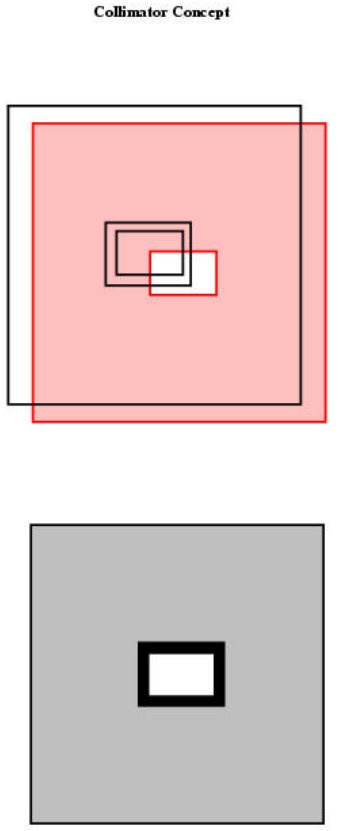
MI8 Collimation

Booster Collimators	MI8 Collimators
10 Hz at 5E12 Protons/pulse	10 Hz at 5E12 Protons/pulse
2% Loss at 8 GeV plus low energy	1% Loss at 8 GeV
Multiturn circulating beam => collimators 1 Horizontal (radial inside) 1 Vertical (bottom) Thin primary plus three secondary	One pass => thick collimators 4 Horizontal (inside, outside at two phases) 4 Vertical (top, bottom at two phases)
Hor, Vert, Pitch, Yaw Control	Horiz, Vert Control
Tunnel not deep	Tunnel deep
Surface occupied	Surface not occupied
Air Activation not serious	Air Activation not serious
Sump Pumps in area actively carry water	Tunnel below water level -- not much sump activity
Ground Water not an issue	Ground Water not an issue

MI8 Collimation



MI8 Collimation



MI8 Collimation

Property	1st Collimator	2nd Collimator
Emittance (h, v)	20 pi-mm-mr	20 pi-mm-mr
$ß_h$	35 m	32 m
$ß_v$	16 m	20 m
0.1% (3.72 σ)	13 mm half-width	12.4 mm half-width
0.1% (3.72 σ)	9 mm half-height	9.8 mm half-height
1% (3.03 σ)	10.7mm half-width	10.2 mm half-width
0.1%(3.03 σ)	7.4 mm half-height	8 mm half-height
dispersion (hor)	<2 m	<2 m
dp/p = 0.001	<2 mm offset	<2 mm offset

MI8 Collimation

MI8 Beam Stability:

Short Term: 1 mm variations (width of distribution)
Long Term: 3 – 5 mm drift

A bit worse vertically for both short and long term

Some measures for MP02 make it appear worse than it is

Moving from dual pulsed septa (MP01-ML01) to single septa (MP02) is about 3 times worse at Main Injector

Readout of MI8BEND is not very precise

Work going forward to examine MP02 supply

MI8 Collimation

How to use this collimator – commissioning and operational issues

Lattice of MI8 is measured to be much like design

BPM upstream measures position in one plane
BPM downstream measures position in other plane.

Can set collimator positions using survey and BPM readings to provide approximate design loss edge, but…..

- **Transmission measurement of loss at even 1% not useful**
- **Loss monitor measurement should be obscured by collimation**

Present plan not very satisfying but can work.

Recent studies showed that loss-free region at LM301 could be greatly enlarged by scraping beam vertically at 839.

MI8 Collimation

Budget: About half of the Booster Cost per Collimator (2 not 4 axes)

Marble (from Kitchen Cabinet Supplier)

1.25” thickness ➔17 lbs/sq foot ➔ $32/sq foot

8 pieces 32” x 45” x 1.25” (170 lbs per piece)
8 pieces 22” x 45” x 1.25” (116 lbs per piece)
540 sq feet $17,280
This price for marble polished on one side and cut ready for pickup

Iron	**$0.50/lb**	**$8580/m^3**	**7.8 gm/cc**
Marble	**$1.88/lb**	**$11167/m3**	**2.7 gm/cc**

MI8 Collimation

Schedule:

Install during 2005 shutdown of MI (December ?)

- **Mechanical Installation**
- **Cable Pulls**

Complete assessment – Radiation documents…

Controls System additions (Prior/during shutdown)

Assemble/Test Collimator Mechanical System

Procurement:

- **Fabricate Mechanical/Vacuum Parts**
- **Purchase Commercial Items**
- **Procure Long Lead Items**

Design/Draft Mechanical System

MI8 Collimation

Issues to Resolve:

- **Beam Motion needs improved control**
  - **Power Supply Work??**
  - **Auto-tune??**
- **Currently have one BPM and one Corrector per half cell. Need more?**
- **Mechanical Design will be same for all locations under consideration**
  - **Choose location in 836-843 or 823-829 or 814-817**
  - **Need to decide on 'horizontal' or 'vertical; half-cell**
  - **Need to decide where along 5.2 m open space**
- **Must protect against mistuning – can only take 100% of beam for seconds**
  - **Take difference of two toroids with 'E-Berm' electronics?**
  - **Set suitable thresholds on loss monitor? (high loss but not too high)**
- **Radiation Assessment awaits civil drawings (requested a week ago).**

MI8 Collimation

Summary:

- **MI8 collimation is capable of reducing halo for MI beam**
- **Mechanical design underway with sound concepts**
- **Simulation is available which supports design concept**
  Summer student will provide details for documentation
- **Important details must be resolved in next few weeks**
- **Radiation Assessment faces no severe problems**
- **Resources appear to be available to meet needed schedule**